

AMENDMENTS TO THE CLAIMS

This listing of claims will replace all prior versions and listings of claims in the application:

LISTING OF CLAIMS:

1. (original): A head driving apparatus, incorporated in an ink jet printer which comprises:

a print head, provided with a plurality of nozzles;

piezoelectric elements, each associated with one of the nozzles and provided with a drive electrode and a common electrode; and

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a head driver, which generates a drive signal for driving the piezoelectric elements, and selectively supplies the drive signal to at least one of the piezoelectric elements to eject an ink droplet from at least one associated nozzle, the head driving apparatus comprising: a bias power source, which applies a bias voltage having a predetermined potential to the common electrode of each piezoelectric element.

2. (original): The head driving apparatus as set forth in claim 1, wherein the potential of the bias voltage is variable.

3. (original): The head driving apparatus as set forth in claim 1, wherein the bias power source is provided as a logic power source.

AMENDMENT UNDER 37 C.F.R. § 1.111
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4. (original): The head driving apparatus as set forth in claim 1, wherein the bias power source generates the bias voltage based on a power supplied from a power source for driving the print head.

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5. (original): The head driving apparatus as set forth in claim 4, wherein the bias power source includes: a condenser, electrically connected to the common electrode; and a constant-voltage circuit, which applies the bias voltage to the condenser.

6. (original): The head driving apparatus as set forth in claim 5, wherein:
the constant-voltage circuit includes a Zener diode, a current limiting resistance and a coupling element;

the Zener diode is electrically connected to the head driving power source through the current limiting resistance; and

the Zener diode is electrically connected to the common electrode through the coupling element.

7. (original): The head driving apparatus as set forth in claim 6, wherein the constant-voltage circuit includes a discharging diode electrically connected to the head driving power source in parallel with the current limiting resistance, such that a current is flowed to the head driving power source through the discharging diode.

8. (original): The head driving apparatus as set forth in claim 1, wherein the bias power source includes:

a first condenser, electrically connected to the common electrode; and

a charger, which charges the first condenser with electric charges discharged from the piezoelectric elements.

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9. (original): The head driving apparatus as set forth in claim 8, wherein the charger includes a second condenser charged with the electric charges.

10. (original): The head driving apparatus as set forth in claim 9, wherein the charger includes a constant-voltage circuit which regulates a charged voltage of the second condenser, and applies the charged voltage to the first condenser.

11. (original): The head driving apparatus as set forth in claim 9, wherein the second condenser is charged before a printing operation is performed.

12. (original): The head driving apparatus as set forth in claim 1, wherein: the bias power source includes:

a condenser, which apply the bias voltage to the common electrode; and

a charger, which charges the condenser based on a power supplied from a power source for driving the print head; and

the bias voltage is substantially identical with an intermediate potential of the drive signal.

13. (original): The head driving apparatus as set forth in claim 12, wherein the charger includes a switcher, which applies the intermediate potential to the condenser when the drive signal is not used for ejecting the ink drop.

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14. (original): The head driving apparatus as set forth in claim 13, wherein the switcher is provided as a switching element.

15. (original): The head driving apparatus as set forth in claim 13, wherein the switcher is controlled in accordance with the drive signal.

16. (original): The head driving apparatus as set forth in claim 1, wherein the bias power source is provided as a reference voltage generator which applies a reference voltage having a potential which is substantially identical with an intermediate potential of the drive signal, to the common electrode.

17. (original): The head driving apparatus as set forth in claim 16, further comprising a charger which generates a charge signal for charging at least one of the piezoelectric elements when the drive signal is not used for ejecting the ink drop, wherein the reference voltage generator includes:

a voltage holder, which latches an arbitrary potential of the drive signal based on the charge signal; and

an current amplifier, which current-amplifies a voltage output from the voltage holder.

18. (original): The head driving apparatus as set forth in claim 16, wherein: the reference voltage generator discharges at least one of the piezoelectric elements when a potential of the drive signal is higher than the intermediate potential while a printing operation is performed; and

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the reference voltage generator charges at least one of the piezoelectric elements when the potential of the drive signal is lower than the intermediate potential while the printing operation is performed.

19. (original): The head driving apparatus as set forth in claim 17, wherein the reference voltage is applied when the charger charges the at least one of the piezoelectric elements, based on the output voltage of the voltage holder.

20. (original): The head driving apparatus as set forth in claim 18, wherein the reference voltage generator includes a discharger which discharges at least one of the piezoelectric elements.

21. (currently amended): A liquid jetting apparatus, comprising:
a jetting head, provided with a plurality of nozzles;

piezoelectric elements, each associated with one of the nozzles and provided with a drive electrode and a common electrode; and

~~the head driving apparatus as set forth in any one of claims 1-20~~ a head driving apparatus comprising a bias power source, which applies a bias voltage having a predetermined potential to the common electrode of each piezoelectric element.

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22. (original): A method of driving a jetting head in a liquid jetting apparatus, comprising the steps of:

providing a liquid jetting apparatus which comprises:
a jetting head, provided with a plurality of nozzles;
piezoelectric elements, each associated with one of the nozzles and provided with a drive electrode and a common electrode; and

a head driver, which generates a drive signal for driving the piezoelectric elements, and selectively supplies the drive signal to at least one of the piezoelectric elements to eject an ink droplet from at least one associated nozzle;

providing a bias power source in the liquid jetting apparatus; and
applying a bias voltage having a predetermined potential from the bias power source to the common electrode of each piezoelectric element.

23. (original): The head driving method as set forth in claim 22, further comprising the step of charging at least one of piezoelectric elements when the drive signal is not used for ejecting the ink drop.

24. (original): The head driving method as set forth in claim 22, further comprising the steps of:

determining a reference potential in the drive signal;

discharging at least one of the piezoelectric elements when a potential of the drive signal is higher than the reference potential while a printing operation is performed; and

charging at least one of the piezoelectric elements when the potential of the drive signal is lower than the reference potential while the printing operation is performed.

25. (original): The head driving method as set forth in claim 22, further comprising the step of varying a potential of the bias voltage so as to follow a potential of the drive signal when the drive signal is not used for ejecting the ink drops.

26. (original): The driving method as set forth in claim 22, further comprising the steps of:

determining a reference potential as an intermediate potential of the drive signal; and

adjusting the bias voltage based on the reference potential.

27. (previously presented): An ink-jet printer driving apparatus comprising:

a print head comprising a plurality of nozzles;

a plurality of piezoelectric elements, each associated with a respective one of the nozzles and comprising a drive electrode and a common electrode; and

a head driver operable to generate a drive signal for driving the piezoelectric elements, and selectively supply the drive signal to at least one of the piezoelectric elements to eject an ink droplet from at least one associated nozzle, the head driving apparatus comprising a bias power source operable to apply a constant bias voltage to the common electrode of each piezoelectric element.

28. (previously presented): An ink-jet printer driving apparatus comprising:

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a print head comprising a plurality of nozzles;

a plurality of piezoelectric elements, each associated with a respective one of the nozzles and comprising a drive electrode and a common electrode; and

a head driver operable to generate a drive signal for driving the piezoelectric elements, and selectively supply the drive signal to at least one of the piezoelectric elements to eject an ink droplet from at least one associated nozzle, the head driving apparatus comprising a bias power source connected directly to the common electrode of each piezoelectric element and operable to apply a bias voltage to the common electrode of each piezoelectric element.

29. (previously presented): A method of driving a jetting head in a liquid jetting apparatus, the method comprising:

providing a liquid jetting apparatus comprising:

a jetting head, provided with a plurality of nozzles;

a plurality of piezoelectric elements, each piezoelectric element associated with one of the nozzles and provided with a drive electrode and a common electrode; and

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a head driver, operable to generate a drive signal for driving the piezoelectric elements, and further operable to selectively supply the drive signal to at least one of the piezoelectric elements to eject an ink droplet from at least one associated nozzle; providing a bias power source in the liquid jetting apparatus; and applying a constant bias voltage having a predetermined potential from the bias power source to the common electrode of each piezoelectric element.
